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A Review of Treatment Methods for Patients with Patellofemoral Pain

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A REVIEW OF TREATMENT METHODS FOR PATIENTS WITH PATELLOFEMORAL PAIN

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This Independent Study, submitted by Kristi Minter in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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ABSTRACT

There have been many therapeutic methods proposed for the treatment of patellofemoral pain, but there still remains some question as to which of these options is most beneficial to the patient. There are many steps to follow in order to find the most effective treatment method for an individual suffering from patellofemoral pain syndrome.

This paper is a review of the literature regarding patellofemoral pain syndrome. The paper begins with a discussion of the anatomy of the patellofemoral joint. Etiological factors of this common syndrome are also presented as well as the clinical presentation of this patient population. The focus of the paper involves treatment techniques for patients with patellofemoral pain. Several months of conservative treatment measures are encouraged preceding more invasive surgical techniques. The surgical techniques discussed here include the lateral retinacular release, proximal patellar realignment, distal patellar realignment, and the patellectomy.

CHAPTER I

INTRODUCTION

Patellofemoral joint pain is a common complaint that affects as many as one in four of the general population[1] and comprises 11.3% of sport-related musculoskeletal problems presented to family physicians.[2] There have been many treatment methods proposed for this problem, both conservative and surgical, but there still remains some controversy concerning which treatment options are the best. The purpose of this paper is to review the anatomy, etiology, and signs and symptoms related to patellofemoral pain and then to explore the different treatment options to determine which have been the most effective.

Patellofemoral pain is characterized by a diffuse pain, usually with an insidious onset, on the anterior surface of the knee. Generally, this pain is aggravated by ascending and descending stairs and by prolonged sitting.[2-6] It is generally worse after activity and often bilateral.[6,7] The patient may also complain of an occasional "giving way" sensation in the affected knee.[2-5]

Anatomically, the patella serves the functions of increasing the mechanical advantage of the quadriceps, distributing the compressive forces of the femur, and protecting the anterior surface of the knee.[4,7-9] The cartilage

covering the patellar facets serves the purpose of protecting the knee from the large stresses of bone-on-bone contact.[8] The patella is stabilized by both dynamic and static stabilizers in the patellofemoral joint.[1,2,4,5,8,10,11] When there is abnormality or insufficiency in any of these structures, the patellofemoral joint can become a source of debilitating pain.

Biomechanical abnormalities are the primary cause of patellofemoral pain.[7,10] These could include factors such as a weak vastus medialis oblique (VMO),[1,8,11-13] increased Q-angle,[7.11,13,14] femoral position or rotation,[2,13,15] changes in patella shape or tibial torsion,[13] patellar instability,[4,9] and overuse of the medial patellar facet.[13] Other etiologies may include a tight lateral retinaculum[10,12,16,17] or excessive talocrural joint pronation[18-20] as well as decreased flexibility of the iliotibial band and hamstrings.[2,3] Variations from normal in biomechanical structures disrupt the balance and function of the joint and lead to patellofemoral pain symptoms.

Treatment methods for patellofemoral pain vary according to the etiology and severity of the symptoms. Conservative techniques are effective in treating 80% of these patients[17] and include treatment such as activity modification, NSAIDs (non-steroidal anti-inflammatory drugs), modalities, bracing or taping, and exercise.[2,4,7,11,17,21,22] If conservative treatments fail, surgical techniques may be indicated to relieve these symptoms. These include techniques such as lateral retinacular release,[2,7,17,23-27] patellectomy,[2,3,7,9,10,13] patellar resurfacing,[2,7,21,28] and patellar realignment.[2,7,23,27,29] The intervention of surgical

treatment is only recommended in cases that have not responded to conservative measures for three to six months.[17,31]

It is important for the clinician to have a good knowledge of the anatomy and biomechanics of patellofemoral joint pain as well as signs and symptoms indicating abnormalities in this joint. Only then will the clinician be able to choose the most appropriate treatment option and rehabilitate the patient to the highest level of function.

CHAPTER II

ANATOMY

It is important for the clinician to first have a good understanding of the patellofemoral joint structure and function before patellofemoral pain symptoms can be interpreted and thereby treated successfully.

The function of the patella is to increase the lever arm and, therefore, the mechanical advantage of the quadriceps, distribute the compressive forces of the femur, and protect the anterior surface of the knee joint.[4,7,8,9] It also acts to centralize the forces of all the quadriceps muscles and gives an attachment for the patellar tendon.[9] The retropatellar surface is made up of three facet joints: the medial and lateral facets and also an odd facet.[11,12] Additionally, the medial and lateral facets are both divided into thirds for a total of seven facets.[11,12,32] These facets are lined with articular cartilage which is aneural and avascular and, due to its insensitivity, is able to sustain high compressive loads, thereby reducing friction in the joint.[4-6,9,12]

This cartilage can begin to soften, causing chondromalacia, and become a source of patellofemoral pain. When this happens, the cartilage develops fissures in its surface through which water content and, therefore, resilience is lost.[12] Because the cartilage does not have a blood or nerve supply, the source

of pain has been attributed either to the subchondral bone when it is required to accommodate more stress or to a stretched lateral retinaculum.[12]

The patella articulates with the trochlea of the femur in flexion and extension of the knee. This articulation is the least congruent joint in the body[32] and, compared to other joints, has among the highest force per unit area.[2] These forces are three times the body weight in stance phase of gait and can increase to eight times the body weight with full flexion.[11,32] Therefore, it is vital that the biomechanics of this joint are ideal for pain free movement of the knee (Figure 1).

The sulcus angle of the femoral condyles is important in the biomechanics of the knee. The lateral femoral condyle is higher and larger than the medial femoral condyle.[11] The sulcus angle is created by two lines from the deepest point in the sulcus to the top of each of the femoral condyles.[5] The normal sulcus angle is 114° to 137° and there is increased risk for lateral subluxation at an angle greater than 127° to 150° due to the flatter surface.[5,12] There are three factors responsible for guiding the patella in the femoral sulcus: 1) the configuration of the patella and sulcus which was just previously discussed, 2) the dynamic stabilizers of the patella, and 3) the static stabilizers.[5]

The dynamic stabilizers of the patellofemoral joint are the quadriceps muscles which originate from the femur and ilium and insert into the patella.[2,4,11] The most important of these is the oblique fibers of the vastus medialis which insert into the patella at a 55° angle and dynamically function to pull the patella

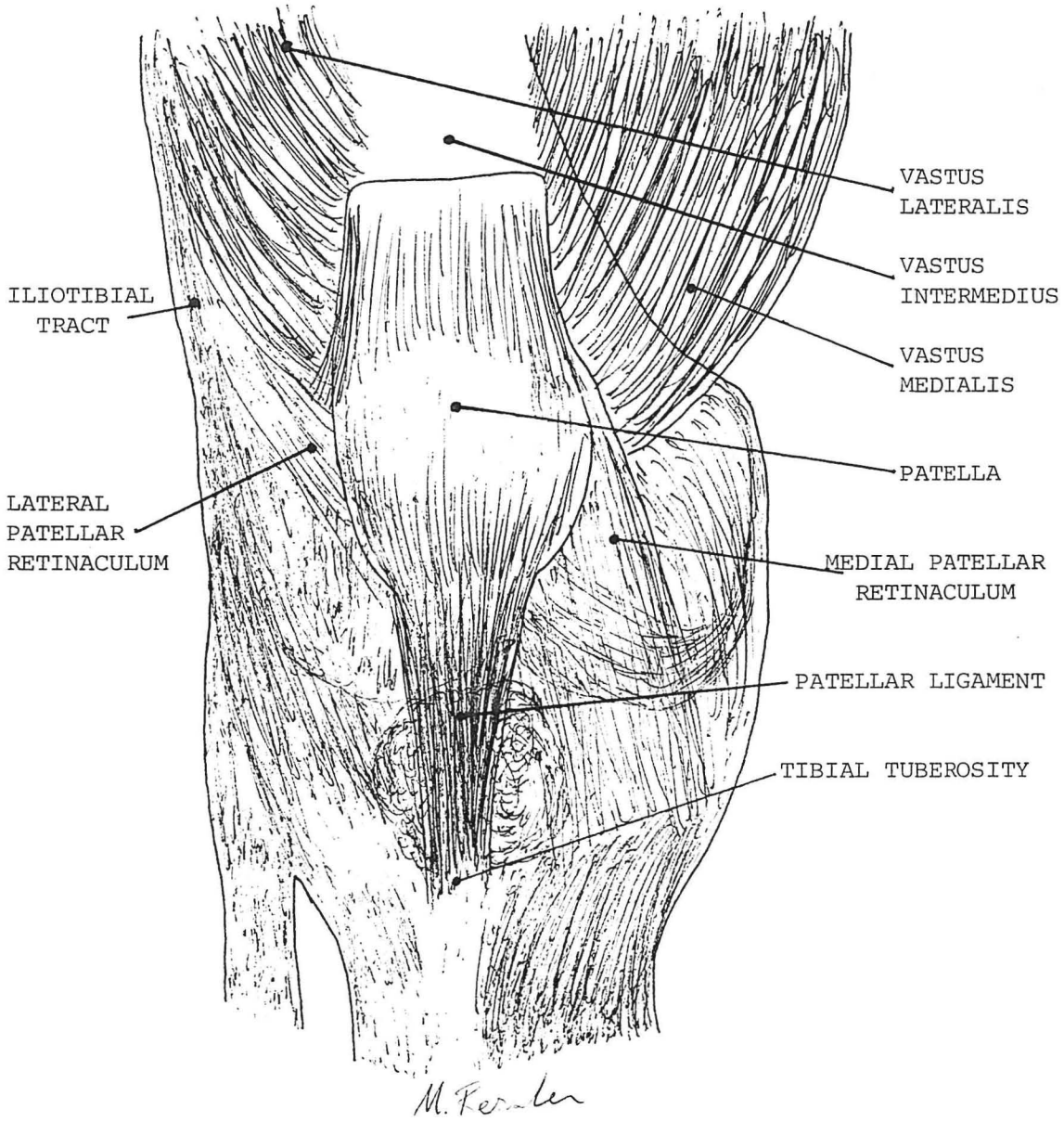

Figure 1.--Patellofemoral anatomy

medially. A weak VMO would then lead to improper tracking and sometimes lateral subluxation of the patella.[1,2,4] The quadriceps insert onto the patella via the patellar tendon. The patella is then attached to the tibia via the patellar ligament.[11,12]

Patellar tracking is influenced greatly by the pull of the quadriceps and their position of attachment onto the patella and ultimately the tibial tubercle.[11] The Q-angle is measured by the insertion of a line extending from the anterior superior iliac spine to the midpoint of the patella and a line from the midpoint of the patella to the tibial tubercle.[4,7,8,14] For men, the average Q-angle is 8° to 14°, and for women it is 11° to 20°.[4,12] If the Q-angle is greater, the patella will tend to track more laterally and may become a source of patellofemoral pain.

The final dynamic stabilizers that affect the patellofemoral joint are the hamstrings. The pes anserine muscle group (semitendinosus, semimembranosus, and gracilis) controls internal rotation of the tibia and the biceps femoris controls external rotation of the tibia.[8] Because of these actions, the hamstring musculature can affect patellar tracking.

The static stabilizers of the patellofemoral joint are also important in the function of this joint. Included in this group are the patellofemoral ligaments which are thickenings of the joint capsule that run from both sides of the midpatella to the femoral condyles. The medial patellofemoral ligament prevents lateral displacement of the patella. The lateral patellofemoral ligament guides

the patella through the femoral sulcus and when excessively tight, contributes to increased compressive forces in the patellofemoral joint.[5]

The patellotibial bands extend from the inferior pole of the patella to the anterior tibia and coronary ligaments, stabilizing the patella by patellofemoral compression.[5,32]

The medial and lateral retinacula attach the vastus medialis and lateralis, respectively, to the patella.[32] The lateral retinaculum is especially important when considering patellofemoral pain syndrome. When this structure is tight, it will encourage lateral subluxation as well as increased pressure on the lateral facet of the patella.[17,32]

All of the previously discussed factors will affect patellar tracking. In a normal knee, as the knee flexes, the contact points on the patella move proximal as the contact points on the femur move distally.[4,8,32] In full extension, the patella rests in the proximal trochlea and contacts the supratrochlear fat pad.[2,8] As the knee flexes to approximately 20°, the patella sits in the trochlea of the femur. At 90° of flexion, the patella contacts the medial and lateral femoral facets of the condylar fossa. Finally, as the knee flexes to 135°, the odd facet of the patella contacts the articulating surface of the medial femoral condyle.[2,8,11]

CHAPTER III

ETIOLOGY

Many factors have been implicated in the cause of patellofemoral joint pain. Malalignment of the lower extremity encompasses many of these factors and may include femoral anteversion, subtalar joint pronation, increased Q-angle, patellar position, genu valgum, and tibial torsion. Synovial plicae, Hoffa disease, trauma, chondromalacia patellae, a tight lateral retinaculum, or a weak VMO may also contribute to the many causes of anterior knee pain. All of these factors are significant when considering the patella and its tracking in the trochlea of the femur. Increased pressure and contact, often caused by lateral patellar tracking, contribute to the symptoms experienced by patients with patellofemoral joint pain.[1-8,11-13,15-17,22-24,37]

Malalignment of the lower extremity is usually measured in terms of the Q-angle.[4] Usually an increase and occasionally a decrease in Q-angle may cause patellofemoral joint pain.[14] An increase in Q-angle will increase the lateral compressive forces in the patellofemoral joint because the pull of the quadriceps is directed more laterally.[8] During weight-bearing activities, the Q-angle may be increased with subtalar joint pronation when the femur compensates by internally rotating on the tibia.[4] Eckoff et al[13] found that patients with anterior

knee pain displayed more femoral anteversion, and therefore an increased Q-angle, than asymptomatic subjects (Figure 2).

A tight lateral retinaculum often contributes to patellofemoral pain. This problem begins in the growth period when the lateral soft tissues of the knee are less compliant than the medial soft tissues. The less compliant lateral tissues restrain the patella into a lateral position which increases the lateral stresses on the patella. With this decreased compliance of lateral structures, the patella may tilt laterally and lead to lateral retinacular strain. The strain causes inflammation and a scarred, shortened lateral retinaculum. With knee flexion, the retinacula tighten and pull the patella posteriorly, leading to pressure on the lateral patellar facet and subsequent patellofemoral pain.[17]

A common condition causing patellofemoral pain is chondromalacia patellae. This refers to abnormal cartilage changes on the retropatellar surface. This condition most commonly affects the medial and "odd" facets where there are roughened and softened areas of articular cartilage. The cause of chondromalacia patellae is repetitive shearing stresses on the cartilage.[23] The pain produced by this condition, and patellofemoral joint pain in general, is not secondary to this cartilage breakdown. Cartilage is avascular and aneural, so there are no pain receptors in this area. Instead, the pain has been attributed to pain receptors in the subchondral bone of the patella, lateral retinaculum, synovium, and joint capsule as well as venous engorgement.[7,17]

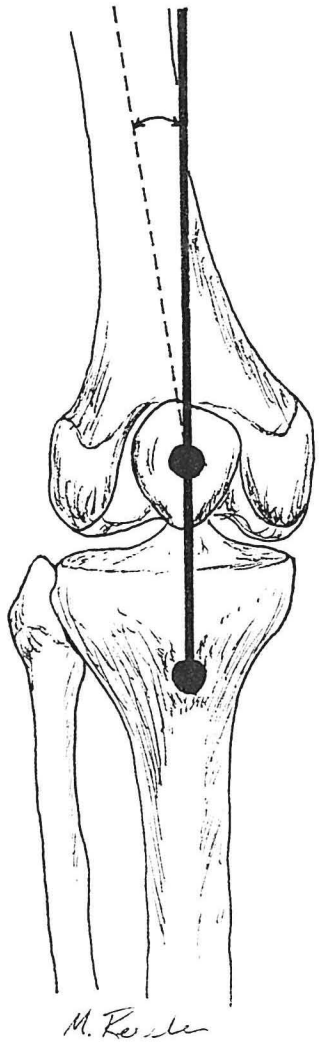

Figure 2.--The Q-angle is measured by the intersection of 1) a line extending from the anterior superior iliac spine to the middle of the patella and 2) a line extending from the middle of the patella to the tibial tuberosity

Weakness of the VMO has been found to be clinically significant when assessing patellofemoral pain. The VMO is the only dynamic structure supporting the knee medially; therefore, weakness of the VMO could potentially cause a lateral tracking of the patella. EMG studies have shown that in nonpainful knees, the VMO to vastus lateralis (the dynamic lateral stabilizer of the patellofemoral joint) activity ratio is 1:1. However, in symptomatic knees, the ratio changed to less than 1:1.[1,4] Once pain has begun and inflammation has started, there tends to be fluid in the knee which can further inhibit the VMO and complicate the problem. As little as 20 to 30 ml of fluid may inhibit the VMO.[1]

For normal patellofemoral joint motion to occur, all of the structures around the joint must be balanced. Decreased flexibility of soft tissues has been implicated as the cause of patellofemoral pain syndrome. If the rectus femoris is tight, it will not allow full patellar mobility which can lead to increased compressive force and pain. The iliotibial (IT) band has a bond connecting to the lateral retinaculum and, as the knee flexes, the band moves posteriorly. Therefore, if the iliotibial band is tight, it will pull the patella laterally. If the hamstrings or gastrocnemius are tight, talocrural dorsiflexion will be limited which will cause compensatory subtalar joint pronation and an increase in Q-angle which again leads to lateral patellar tracking.[4]

Occasionally, patellofemoral pain is caused by a single traumatic event or an episode of subluxation or dislocation.[7] This is often a direct blow from the dashboard in a motor vehicle accident. This could result in cartilage softening

(chondromalacia), osteochondral fracture, or loose bodies that would suggest patellofemoral joint pathology.[33] The symptoms are the same as in other groups of patients.[12]

Patellofemoral pain is oftentimes an overuse injury. Patellar tendinitis or "jumper's knee" may cause patellofemoral symptoms. Activities which require repetitive motion, such as running and cycling, are often the cause of this type of injury that presents with patellofemoral pain symptoms.[8,11]

Medial patellar plica may also give rise to patellofemoral pain symptoms. Embryologically, during the fourth fetal month, the knee is formed by fusion of three synovial compartments. Normally, the intervening synovial tissue is resorbed, but when these tissues are not resorbed, plicae are formed. There are three of these plicae: 1) the infrapatellar, 2) the suprapatellar, and 3) the medial patellar. The medial patellar plica is the most commonly clinically significant. When the knee is flexed from 30° to 60°, the medial patellar plica glides over the medial femoral condyle. With the tibia in external rotation, the plica is wedged between the medial patellar facet and the medial femoral condyle. Here, it is subjected to injury that may give rise to patellofemoral pain symptoms.[35]

Finally, the importance of differential diagnosis should be addressed. Lower extremity and back problems can refer pain to the knee. The clinician must conduct a thorough evaluation to distinguish true knee pathology from other potential sources of symptoms.[3]

CHAPTER IV

CLINICAL EVALUATION

A careful history must be taken and extensive examination completed by the clinician when evaluating patients suffering from anterior knee pain. The examination will allow the clinician to determine the exact cause of pain and thereby choose the appropriate treatment methods. The examination should include a patient history, observation, palpation, special tests and measures, and possibly radiographic examination.[2] This assessment should include screening for a differential diagnosis in order for the clinical to accurately determine the cause of the undesirable symptoms and treat the patient appropriately.

The evaluation should start with a careful history which will often narrow the diagnosis before a physical exam is even performed.[2] A patient suffering from patellofemoral pain will present to a clinician with some typical signs and symptoms. The patient is often a young man or woman, more often a teenage girl, who is 10 to 20 years old. The patient will complain of diffuse pain on the anterior surface of the knee[1,7,12] or occasionally along the medial patella.[2,36] Most commonly, this pain will have an insidious onset, but it may follow a traumatic injury in which there has been blunt trauma to the anterior patellar

surface. This frequently occurs in a motor vehicle accident when the knees strike the dashboard.[2,12] This pain is generally worse when ascending or descending stairs, after activity, or after sitting for prolonged periods. Anterior knee pain is frequently bilateral, but one knee may be more affected than the other.[1,2,4,5,12,22,23] The patient may complain of crepitus, or a feeling of grinding, in the joint and may also complain of a clicking or "giving way" sensation in the knee. In more severe cases, the patient may even report lateral dislocation or subluxation of the patella.[2,7,33] Commonly, patellofemoral pain symptoms are associated with overuse activities or degenerative changes seen in patients with arthritis.[12]

After a complete history has been taken, a physical examination should follow. The clinician may begin this examination by simply observing the patient. It is common to find atrophy of the quadriceps muscles in the affected knee(s), particularly of the VMO.[5] The examiner may take a circumferential measurement of the distal thigh and compare it to the uninvolved extremity to determine atrophy.[31] The examiner may find evidence of some soft tissue swelling, although significant edema is rare. The examiner should also observe the patient's gait to assess changes secondary to pain or discomfort or to assess for the presence of biomechanical abnormalities, such as excessive pronation. The clinician should additionally assess the static posture of the patient to determine if the patellar are facing anteriorly[2] and to note excessive femoral anteversion, genu varum or valgum, or pronated feet.[31]

The clinician should perform special tests and measurements to further assess the patient's complaints. The patellar apprehension test will determine if there is lateral instability of the patella. This test is performed with the knee in 30° of flexion while the examiner applies medial pressure to force the patella laterally. Pain or fear of pain associated with lateral subluxation is a positive patellar apprehension test.[2,31] The patellofemoral grind test can also be performed. To perform this test, the examiner applies anterior pressure to the patella, pushing it into the trochlea of the femur, and asks the patient to contract the quadriceps. This test is positive if the patient has complaints of pain with contraction of the quadriceps and is indicative of inflammation and irritation of the patellar cartilage as well as possible degenerative changes.[2,23,31]

The sage sign may be used to determine tightness of the lateral retinaculum. The patient is positioned supine with the knee relaxed and flexed 20°. The examiner then pushes the patella medially. If the patella displaces less than 1/4 of the greatest patellar width, the sage sign is considered positive.[31] The clinician may also use the patellar glide test with the patient in the same position. The patella is divided into four quadrants; the examiner applies pressure both medially and laterally to determine patellar excursion into these quadrants. A lateral patellar glide of three or more quadrants indicates an insufficient medial restraint, while a medial glide of one quadrant or less indicates a tight lateral retinaculum. A positive sage sign or patellar glide test may predispose the patella to lateral subluxation.[17,31]

Range of motion of the hip and knee should also be assessed. Although range of motion is usually normal in patients with patellofemoral pain syndrome, a decrease in range of motion may indicate a differential diagnosis in the hip or knee and must be further evaluated.[2]

The patient's Q-angle should be determined by measuring the angle formed by a line extending from the center of the patella to the anterior superior iliac spine and a line extending from the center of the patella to the tibial tubercle. This angle should be less than 10° in men and less than 15° in women.[2,29] An increased Q-angle predisposes the patella to lateral subluxation.[2]

Assessment of the patient's flexibility should also be a part of the physical exam. Tightness of the iliotibial (IT) band is found by using Ober's test in which the patient is sidelying with the affected leg on top and the bottom hip and knee flexed. The hip and knee of the top leg are flexed to 90°. The hip is passively abducted, hyperextended, and allowed to adduct by the therapist. The top hip should adduct at least past neutral. Tightness of the IT band would indicate the need for stretching exercises to lengthen this structure. Hamstring flexibility may also be assessed and can be performed by simply asking the patient to lie supine with the knee in full extension while the therapist passively flexes the hip. The patient should tolerate at least 90° of hip flexion.[2]

Palpation is an important part of the physical exam and should be performed with the patient positioned supine and the knee relaxed. Palpation should begin with the least painful knee. Tenderness of the medial and lateral

joint lines, patellar facets, and the prepatellar and suprapatellar areas should be specifically noted. If there is tenderness in the medial or lateral joint lines, further assessment is needed to rule out injury to the lateral collateral and medial collateral ligaments. Patellar facet tenderness can result from repetitive abnormal patellar tracking a well as patellar subluxation or dislocation.[2,12]

A radiographic examination may be indicated for some patients suffering from patellofemoral pain. Ruffin and Kiningham[2] suggest that radiography be performed for the following patient populations: 1) patients with recent leg or knee trauma, 2) patients whose growth plates are still open, 3) patients with symptoms lasting longer than three months, 4) patients whose pain limits their usual daily activities, 5) patients who participate in high-energy contact sports, or 6) patients who are unlikely to receive follow-up care.

It is widely accepted that radiographs are helpful, if not essential, in the diagnosis of patellofemoral pain.[2,5,7,12,17,29,31] Many authors suggest anteroposterior, lateral, and axial views when assessing the patellofemoral joint.[7,29,31] However, it has been found that CAT (Computerized Axial Tomography) scans are even more effective in viewing this joint because the posterior portion of the femoral condyles, which gives a more reproducible measure of patellar tilt, is more visible using this method.[17,29] These radiographic techniques will not only detect malalignment and joint surface abnormalities, but will also serve to rule out other pathological conditions.[2,12]

Before a treatment plan can be established, a differential diagnosis should be considered. Tria, Polumbo, and Alicia[12] report that the differential diagnoses that should be considered include meniscal tears, medial plica syndrome, arthritis, tumors, ligament injuries, and osteochondritis dissecans. The last of these diagnoses is of particular importance because, in a patient suffering from osteochondritis dissecans, the subchondral bone and overlying cartilage separates from the surrounding bone. This condition can be worsened if aggressive rehabilitation is undertaken, especially with weight-bearing activities.[2]

It is also important for the clinician to differentiate between pain caused by the structures of the patellofemoral joint and referred pain. For example, a limitation in hip motion may indicate a source of referred pain to the knee.[33] Hip pathologies, such as slipped capital femoral epiphysis and Legg-Calvé-Perthes disease may refer pain to the knee.[7] Therefore, a peripheral joint scan and elimination of a differential diagnosis is mandatory for the clinician to perform.

After the clinical evaluation is completed, including history, physical exam, radiographic studies, and differential diagnosis, the clinician may then determine the best treatment options for the patient.

CHAPTER V

CONSERVATIVE TREATMENT METHODS

Ninety to ninety-five percent of patients suffering from patellofemoral pain respond to conservative treatment methods.[7,12] These measures should always precede more aggressive surgical intervention. The conservative treatment taken is dependent upon the abnormalities found during the clinical evaluation. Several of these treatment options will be discussed in this section.

For normal patellofemoral tracking to occur, there must be a balance in the soft tissues surrounding the joint.[4] Stretching tight tissues, such as the lateral retinaculum, iliotibial band, or muscles with decreased flexibility, may be indicated to restore patellofemoral joint alignment. The structures to be stretched may include the hamstrings, hip flexors and adductors, the iliotibial band, quadriceps, gastrocnemius, and the soleus.[2,4,8,29,33] Stretching exercises should be slow and sustained and are more effective if the patient performs some sort of gentle warm-up exercise prior to stretching.[33]

Strengthening of the quadriceps musculature is also indicated[11,14] and is the primary treatment approach according to Tria et al.[12] There is usually emphasis on strengthening the vastus medialis which will help pull the patella medially and thereby decrease the prevalence of lateral patellar subluxation as

well as the compressive forces on the lateral femoral condyle.[13,29,33] Strengthening exercises can begin immediately after diagnosis and may consist of isometrics or dynamic resistive exercise. These should be performed in the last 30° of knee extension to allow for strengthening with minimal forces across the patellofemoral joint. The patient is positioned supine with the unaffected knee flexed to avoid stress on the low back. The patient may then perform quad sets, short arc quads with an ankle weight, or straight leg raises. The straight leg raise should be performed with the hip in slight external rotation to more accurately target the vastus medialis.[2,4,12]

These patients should perform these exercises four times per day for 15 minutes.[23] Exercises for quadriceps strengthening may also be performed without professional assistance by using University (Universal Gym Equipment, Cedar Rapids, IA), Nautilus (Nautilus Sports/Medical Industries, Dallas, TX), or Cybex (Division of Lumex, Ronkonkoma, NY) equipment. However, these devices are not necessary and could possibly be detrimental secondary to the increased compressive forces through the patellofemoral joint when it is taken through its full range of motion.[12]

It is important to target the VMO during these strengthening exercises.[2,29,33] The VMO can be activated as a single motor unit, and therefore patients should learn to isolate contraction of the VMO. Tactile cuing, electrical stimulation, and biofeedback techniques have facilitated the targeting of this structure.[1,4,15] Biofeedback allows the patient to selectively train the VMO be

reinforcing VMO activity with an audible tone or visual feedback. The patient then learns to maintain the VMO contraction while relaxing the vastus lateralis.[1,4] Adduction exercises may also be incorporated into the strengthening program because, during adduction, the VMO activity is significantly greater than vastus lateralis activity which would again allow for selective training of the VMO. Electrical stimulation of the VMO is also helpful in the muscle re-education process and should be adjusted in intensity according to patient tolerance. Tolerance may be increased by using ice massage prior to electrical stimulation. Application of cold will decrease sensitivity to the current.[4]

Patellar bracing has been recommended but is to be used as an adjunct to other treatment methods.[2,4,11,29] Many types of braces have been used, ranging from simple straps to devices with hinges, pressure pads, and counters. These braces may be effective in decreasing swelling and pain as well as restoring and maintaining biomechanical alignment, dissipating force, stretching the patellofemoral ligament and lateral retinaculum, preventing stretching of the medial retinaculum, and preventing lateral patellar subluxation and dislocation. The braces may help decrease pain due to alteration of circulation, or they may alter sensory feedback which decreases the patient's awareness of discomfort. The braces may have a cutout for the patella to hold it from tracking laterally, or they may reduce valgus rotation at the knee which again prevents lateral patellar subluxation.[11] Care should be taken when using patellar cutout braces secondary to their detrimental effect on the quadriceps. They can lead to

atrophy of the extensor mechanism if used for prolonged periods and, therefore, aggravate the problem they were designed to alleviate.[12] It should again be emphasized that braces be used in conjunction with a more extensive treatment program and not be expected to rectify the problem alone.

Taping techniques function on the same principle as bracing. Taping may be effective for many reasons. Primarily, taping is used to facilitate exercises during the rehabilitation process. These techniques may promote rehabilitation by decreasing pain, holding the patella in proper alignment, or reducing soft tissue stresses. Patellar taping techniques pull and maintain the patella in a medial position.[12,29,33] These techniques should be used carefully so as to avoid skin compromise and allergic reaction.[12]

Another addition to a patellofemoral treatment program may include the use of orthotics.[11,18,20,33-36] Abnormal foot position may affect lower extremity alignment and predispose the patient to overuse syndromes of the knee. Excessive pronation has been highly correlated with patellofemoral pain syndrome. Excessive pronation causes alternation of the normal rotation of the tibia during stance phase of gait which consequently disrupts the normal patellofemoral relationship.[20] The purpose of a foot orthotic device inserted between the foot and shoe is to bring the foot into a more neutral position and thereby allow a more normal lower extremity alignment.[18,20,30] It is suggested that forefoot varus or calcaneal valgus greater than five degrees be treated because these amounts are likely to lead to lower extremity symptoms.[19,20] Eng and

Pierrynowski[19] in 1994 found that orthotics are effective in changing forefoot varus and calcaneal valgus as well as transverse and frontal plane movement in the knee during walking and running. Eng and Pierrynowski[20] in 1993 also found that when comparing two groups of patients with patellofemoral pan syndrome, the group that used orthotics in addition to the other treatment methods showed a significant improvement in pain symptoms. Therefore, it is suggested that patients who exhibit excessive pronation during evaluation of patellofemoral pain syndrome be considered for orthotics.

A variety of therapeutic modalities have been used in the treatment of patellofemoral pain syndrome. Ruffin and Kiningham[2] suggest the use of ice massage applied to the affected area six times per day for 10 to 15 minutes each time, especially during the acute phase. Ultrasound has also been recommended as an adjunct to therapy acting to increase flexibility of tight structures, such as the lateral retinaculum.[29]

Medications are indicated in some cases of patellofemoral pain syndrome. The most frequently used medications in the treatment of this syndrome are non-steroidal anti-inflammatory drugs (NSAIDs).[4,11-13,22,23,29,33] These drugs are not effective in patients suffering from patellar instability alone, but more effective for patients with acute exacerbations of symptoms.[4,12] Anti-inflammatory medications will inhibit the inflammatory process and may serve a protective role in the breakdown of hyaline cartilage.[12] Bentley and Dowd[23] recommend 600 mg of aspirin four times per day for six weeks in the early

treatment of chondromalacia, whereas Tria et al[12] advise extreme caution in the use of NSAIDs secondary to their side effects of gastrointestinal irritation as well as other complications. Analgesics may also be indicated for patients with a significant amount of pain.[11]

Activity modification is essential for patients suffering from patellofemoral pain syndrome.[11-13,22,23,33] Clinicians should educate their patients by encouraging them to avoid activities that exacerbate their symptoms. Going up and down stairs, excessive walking, kneeling, deep knee bending, and crouching should be avoided.[22,23] Flexion beyond 100° should be avoided, and it may even be necessary to avoid all sporting activities that lead to discomfort.[12] Reduction of painful activities for a period of time may be all that is required to eliminate symptoms.[23]

An aquatic therapy program could be very beneficial to a patient suffering from anterior knee pain. Many of the previously described activities can be performed in the pool where there is less stress on the knee joint. Initiation of weight-bearing, strengthening, ambulation, and range of motion exercises can be incorporated into an aquatic therapy program, while greater muscle relaxation can occur secondary to the decreased pain and calming effects of warm water.[4]

The previously discussed treatment plan can be very effective in treating patellofemoral pain syndrome. Special attention should be given to the deficits or abnormalities found during the clinical evaluation and those deficits addressed in an appropriate treatment program by a competent clinician.

CHAPTER VI

SURGICAL TREATMENT METHODS

If conservative treatment options fail, surgical intervention may be indicated for the relief of patellofemoral pain symptoms. Many surgical treatment methods have been proposed, and for the purpose of this paper, several of them will be discussed. Lateral retinacular release, proximal realignment, distal realignment, and patellectomy will be discussed along with the indications and complications of these procedures.

The lateral retinacular release is the most common procedure performed on patients who failed to respond to conservative treatment methods.[24] The purpose of the procedure is to relieve excessive retinacular strain, thereby restoring a laterally tilted patella to normal alignment.[2,24] Fu and Maday[17] believe that the release may act to denervate the painful lateral retinaculum, thereby reducing pain. The release involves cutting the lateral retinaculum from the vastus lateralis superiorly to the tibial tuberosity inferiorly.[17,24,26,31] This technique can be done arthroscopically or an incision can be made through the skin and tissues overlying the lateral retinaculum. Apparently, the advantage of performing a lateral release arthroscopically is in the cosmetic appearance. However, there is higher incidence of hemarthrosis and hemorrhage due to the

laceration of the lateral superior geniculate artery with this technique.[31] Some authors believe the benefits of using the arthroscopic technique probably outweigh the risks of using this procedure.[17]

When determining if a lateral release should be performed, several factors must be considered. Some authors recommend a CT scan to evaluate exact patellar position before a release is performed.[17,24] This may be important because lateral release is only indicated in patients with an abnormally aligned patella, especially one with a lateral tilt.[2,24] Mori et al[36] found only 50% fair results in patients with unstable patellae who received a lateral release, but 82% to 85% of other patient groups had excellent results. Scuderi[31] agrees that unstable patellae do not usually have good results with a lateral release. He also feels that a lateral tilt, lateral retinacular pain with a lateral patellar position, and excessive lateral pressure syndrome are all indications for a lateral release.

The lateral retinacular release has been associated with complications, although there is generally a good result. Complications may include hemarthrosis or effusion, which can be aspirated and does not generally lead to long-term poor results. Deep vein thrombosis has also been reported in these patients, although this is very rare. There is also a potential for medial subluxation of the patella after a lateral release, which can generally be avoided if care is taken not to detach the vastus lateralis. Reflex sympathetic dystrophy may also develop after a lateral retinacular release.[17,26,27]

Rehabilitation after a lateral release is important. According to Fu and Maday,[17] a cold compression device should be used immediately following surgery to control post-operative swelling. The patient should use this device three times per day for the first week and then as needed after therapy sessions. Full weight-bearing with crutches is allowed immediately, and the patient is encouraged to move the knee as tolerated. Patellar mobilization and quadriceps setting begin after swelling is controlled. Physical therapy is recommended two to three times per week for six weeks and then exercises are continued at home. Patients can return to sports when their involved knee is pain free and has at least 80% of the strength of the uninvolved knee.

For patients who experience lateral subluxation or dislocation of the patella, a proximal patellar realignment may be indicated (Figure 3). This technique is also appropriate for patients whose patellae fail to centralize after a lateral release.[26,31,33] This technique restores patellofemoral congruence by releasing lateral structures, especially the vastus medialis. The surgical procedure begins with a lateral release followed by tightening of the medial structures. This is accomplished by making a midline incision through the quadriceps tendon, extending along the medial border of the patellar tendon. Realignment is effected by drawing the vastus medialis and medial flap distally and laterally, thereby tightening the medial structures.[27,31]

Postoperatively, these patients begin CPM (continuing passive motion) and quadriceps exercises immediately. After patients achieve 120° of flexion

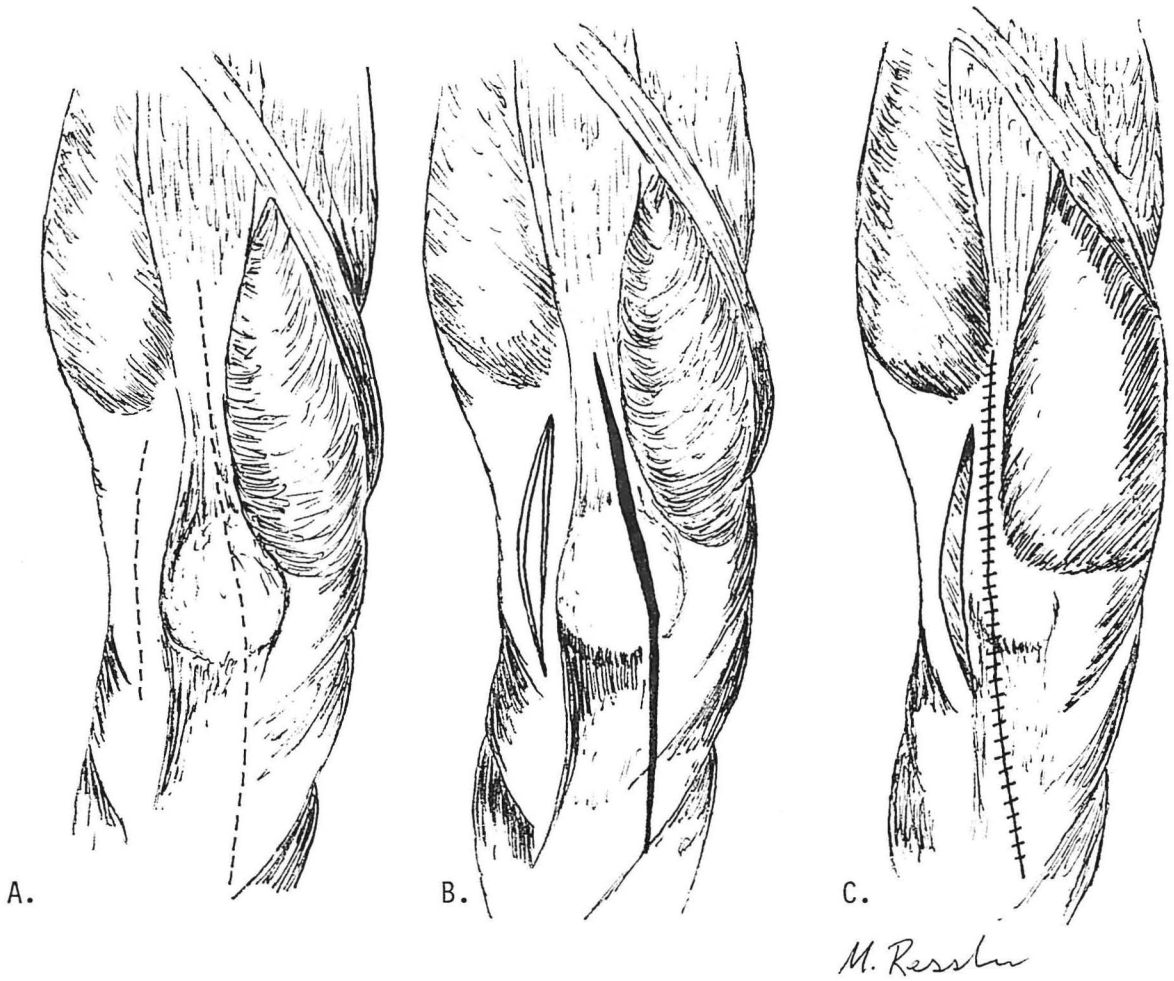

Figure 3.--Proximal patellar realignment. A) Extensor mechanism is first exposed; B) medial flap is made and a lateral release performed; C) medial flap is advanced laterally and distally

and can perform a straight leg raise, progressive resistive exercises can begin. When the strength of the patient's involved knee is 90° of the uninvolved knee, the patient can resume recreational activities. Overall, there have been good results with this technique.[31]

There have been complications reported following proximal patellar realignment. These include recurrent instability, medial subluxation, patellar malrotation, and loss of motion. To avoid these complications, care is taken during the procedure to avoid excessive tightening of the medial capsule, and repeated flexion and extension is performed to ensure centralization of the patella. Also, the medial retinaculum should not be advanced below the equator of the patella as this may cause a rotational malalignment.[27,31]

Still another surgical technique used to realign the patella is a distal patellar realignment (Figure 4). This technique can be done in two ways. The first technique is for patients who are skeletally mature and the second for patients who are not.[26,28] This technique is indicated for patients with recurrent lateral subluxation or dislocation, lateral patellar tilt, or an increased Q-angle.[31]

The first technique for distal realignment involves transferring of the tibial tubercle to a more medial position and is indicated only for patients who are skeletally mature.[27,31] A lateral release is first performed, followed by osteotomy and medial transfer of the tibial tubercle and patellar tendon to restore a normal Q-angle. This technique may be combined with anterior displacement of the

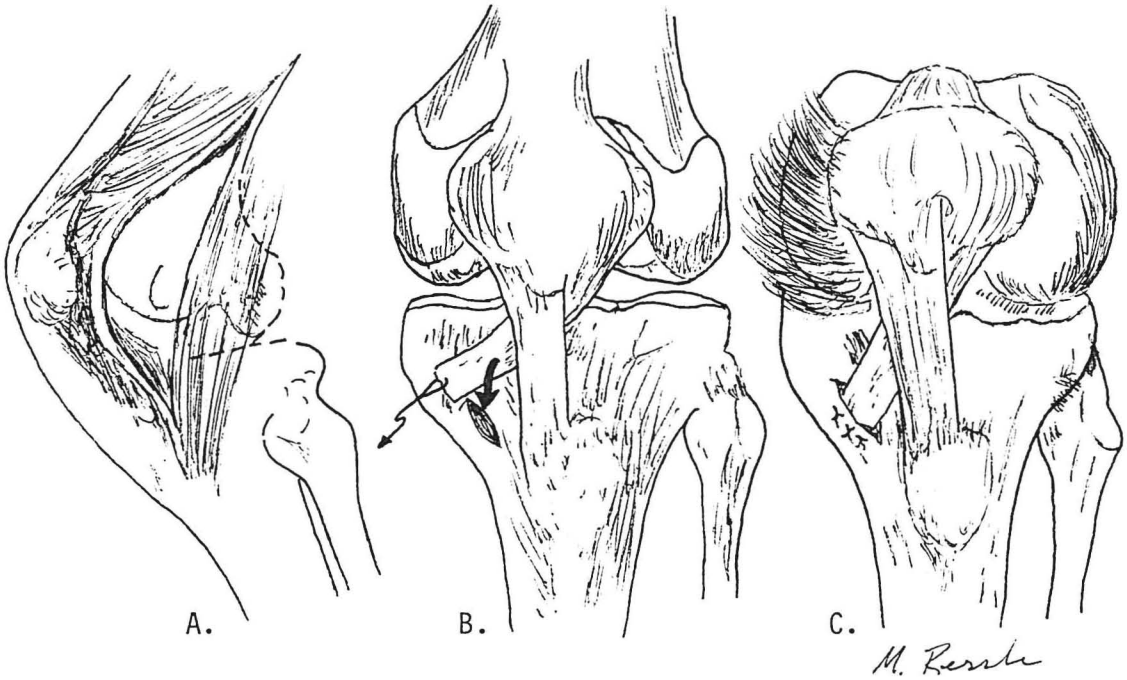

Figure 4.--Distal patellar realignment. A) Lateral release; B) Medial transfer of the lateral 2/3 of the patellar tendon; C) medial reefing

tibial tubercle in cases in which there is subluxation with severe articular degeneration.[33]

The second technique involves changing the insertion of the patellar tendon without disrupting bone and is appropriate even for patients who are not yet skeletally mature.[29,31] First, a lateral release is performed. Then the lateral 2/3 of the patellar tendon is separated from the rest of the tendon and passed medially beneath the medial 1/3 of the tendon. The lateral 2/3 of the tendon is then sutured to the medial tibia, medial retinaculum, and medial ligament.[23,27,29,31] This technique would again realign the patella to a more biomechanically normal position.

Rehabilitation following this technique would include a cast for three weeks, after which mobilization can begin. Ambulation in the cast can begin after 48 hours and quadriceps exercises are begun immediately.[23]

Numerous complications have been reported using this surgical technique. They may include loss of range of motion, premature closure of the epiphysis in patients who are not skeletally mature, displacement of the bony block distally, infrapatellar tendon rupture, neurovascular injury, medial patellar subluxation, compartment syndrome, lateral subluxation, patella baja, and osteoarthritis.[27] Because of these complications, success rates have varied from 93% success to high failure rates. To avoid these complications, careful selection of appropriate subjects should be performed. Ideal candidates have

mostly symptoms of instability and anatomic malalignment and show minimal signs of articular degeneration.[27,29,31]

The final surgical treatment technique that will be discussed here is the patellectomy. The surgical treatment methods discussed previously have decreased the need for patellectomy considerably. Alignment procedures are generally a better option, and patellectomy should be reserved for patients who fail to respond to those procedures. The simplest and most common technique of patellectomy involves enucleation of the patella (removal of the entire patella) through an incision in the quadriceps expansion, followed by closure of the incision.[9,23] Since the lever arm and subsequently the force of the quadriceps is decreased by removal of the patella, it has been suggested that anterior displacement of the tibial tubercle accompany a patellectomy to again lengthen the lever arm.[9]

To allow healing, the involved knee is generally casted for three weeks, after which it can be mobilized. It is very important to emphasize quadriceps strengthening during rehabilitation due to the decreased mechanical advantage of the quadriceps.[23]

Complications of a patellectomy include a decrease in quadriceps strength and compromised function of the quadriceps and hamstrings as well as decreased knee flexion in stance phase of gait and while ascending and descending stairs. Additionally, this procedure alters the cosmetic appearance

of the knee.[9,27] For these reasons, the patella should be preserved whenever possible.[27]

CHAPTER VII

CONCLUSION

Patellofemoral pain syndrome is a common musculoskeletal problem affecting many athletes as well as the general population. Many treatment methods have been proposed, and the treatment for this syndrome varies from patient to patient.

It is necessary for the clinician to have a good knowledge of the anatomy of the patellofemoral joint and to understand the different etiologies of patellofemoral pain syndrome in order to effectively treat this patient population. For this reason, these topics were presented in this paper.

During the clinical evaluation, the clinician should take a complete history and perform a complete evaluation including special tests and measures to determine the exact etiology of the patient's pain. Additional radiographic assessment may be necessary to more accurately define the source of pain. Each patient should be treated according to the deficits or abnormalities found during the clinical evaluation.

Conservative treatment methods should be the first option for all patients who exhibit patellofemoral pain syndrome. These techniques may include strengthening, stretching, bracing, electrical stimulation, modalities, and

medications, to name only a few. If these conservative measures fail, surgical intervention may be indicated. Those discussed here included the lateral retinacular release, proximal patellar realignment, distal patellar realignment, and patellectomy. The lateral release is generally the most common surgical technique and is indicated for patients with a tight lateral retinaculum. The realignment techniques are most appropriate for patients who exhibit an increased Q-angle and experience lateral patellar subluxation or dislocation. The patellectomy is reserved for patients who do not respond to other treatment methods.

REFERENCES

1. Felder CR, Leeson MA. The use of electromyographic biofeedback for training the vastus medialis obliquus in patients with patellofemoral pain. Electromyography. Rehabilicare. New Brighton, Minn: Thought Technology Ltd; 1990.

2. Ruffin MT IV, Kiningham RB. Anterior knee pain: the challenge of patellofemoral syndrome. Am Fam Physician. 1993;47(1):185-194.

3. Tippett SR. Referred knee pain in a young athlete: a case study. JOSPT. 1994;19(2):117-120.

4. Zappala FG, Taffel CB, Scuderi GR. Rehabilitation of patellofemoral joint disorders. Orthop Clin North Am. 1992;23(4):555-566.

5. Larson RL, Cabaud HE, Slocum DB, James SL, Keenan T, Hutchinson T. The patellar compression syndrome: surgical treatment by lateral retinacular release. Clin Orthop. 1978;July-August(134):158-167.

6. Goodfellow J, Hungerford DS, Zindel M. Patello-femoral joint mechanics and pathology. J Bone Joint Surg. 1976;58B(3):287-299.

7. Goldberg R. Chronic anterior knee pain in the adolescent. Pediatric Annals. 1991;20(4):186-193.

8. Woodall W, Welsh J. A biomechanical basis for rehabilitation programs involving the patellofemoral joint. JOSPT. 1990;11(11):535-542.

9. Kelly MA, Brittis DA. Patellectomy. Orthop Clin North Am. 1992;23:657-663.

10. Kaufer H. Patellar biomechanics. Clin Orthop. 1979;144:51-54/.

11. Cherf J, Paulos LE. Bracing for patellar instability. Clinics in Sports Medicine. 1990;9:813-820.

12. Tria AJ, Palumbo RC, Alicia JA. Conservative care for patellofemoral pain. Orthop Clin North Am. 1992;23:545-554.

13. Eckhoff DG, Montgomery WK, Kilcoyne RF, Stamm ER. Femoral morphometry and anterior knee pain. Clin Orthop. 1994;302:64-68.

14. Caylor D. Filts R, Worrell T. The relationship between quadriceps angle and anterior knee pain syndrome. JOSPT. 1993;17:11-16.

15. Voight ML, Wieder DL. Comparative reflex response time of vastus medialis obliquus and vastus lateralis in normal subjects and subjects with extensor mechanism dysfunction. American Journal of Sports Medicine. 1991;19:131-137.

16. Ehrat M, Eduards J, Hastings D, Worrell T. Reliability of assessing patellar alignment: the A-angle. JOSPT. 1994;19:22-27.

17. Fu FH, Maday MG. Arthroscopic lateral release and the lateral patellar compression syndrome. Orthop Clin North Am. 1992;23:601-612.

18. Gross ML, Napoli RC. Treatment of lower extremity injuries with orthotic shoe inserts. Sports Medicine. 1993;15:66-70.

19. Eng JJ, Pierrynowski MR. The effect of soft foot orthotics on three-dimensional lower-limb kinematics during walking and running. Phys Ther. 1994;74:836-844.

20. Eng JJ, Pierrynowski MR. Evaluation of soft foot orthotics in the treatment of patellofemoral syndrome. Phys Ther. 1993;73:62-70.

21. Vaquero J, Arriaza R. The patella thinning osteotomy: an experimental study of a new technique for reducing patellofemoral pressure. International Orthopaedics. 1992;16:372-376.

22. Magi M, Branca A, Bucca C, Langerame V. Hoffa disease. Divisione di Chirurgia del Ginocchio e Chirurgia Artroscopica, Ospedale di Bormio e Sondalo.

23. Bentley G, Dowd G. Current concepts of etiology and treatment of chondromalacia patellae. Clin Orthop. 1994;October:209-228.

24. Shea VP, Fulkerson JP. Preoperative computed tomography scanning and arthroscopy in predicting outcome after lateral retinacular release. Journal of Arthroscopic and Related Surgery. 1992;8:327-334.

25. Fulkerson J, Gossling HR. Anatomy of the knee joint lateral retinaculum. Clin Orthop. 1980;Nov-Dec:183-188.

26. Busch MT, DeHaven KE. Pitfalls of the lateral retinacular release. Clinics of Sports Medicine. 1989;8:279-290.

27. Evans IK, Paulos LE. Complications of patellofemoral joint surgery. Orthop Clin North Am. 1992;23:697-710.

28. Kolettis GT, Stern SH. Patellar resurfacing for patellofemoral arthritis. Orthop Clin North Am. 1992;23:665-673.

29. Post WR, Fulkerson JP. Distal realignment f the patellofemoral joint. Orthop Clin North Am. 1992;23:631-643.

30. Karlsson J, Sward L, Lansinger O. Bad results after anterior advancement of the tibial tubercle for patellofemoral pain syndrome. Archives of Orthopaedic and Trauma Surgery. 1992;111:195-197.

31. Scuderi GR. Surgical treatment for patellar instability. Orthop Clin North Am. 1992;23:619-630.

32. Norkin CC, Levangie PK. Joint Structure and Function: A Comprehensive Analysis. 2nd ed. Philadelphia, Pa: F. A. Davis Company; 1992:366-375.

33. Post WR, Fulkerson JP. Anterior knee pain — a symptom not a diagnosis. Bulletin on the Rheumatic Diseases. 42:5-7.

34. Alnekinders LC, Alnekinders SV. Outcome in the treatment of chronic overuse sports injuries: a retrospective study. JOSPT. 1994;19:157-161.

35. Nottage WM, Sprague NF, Auerbach BJ, Shahriareo H. The medial patellar plica syndrome. American Journal of Sports Medicine. 1983;11:211-214.

36. Mori Y, Fujimoto A, Okumo H, Kuroki Y. Lateral retinaculum release in adolescent patellofemoral disorders: its relationship to peripheral nerve injury in the lateral retinaculum. Bulletin of the Hospital for Joint Diseases Orthopaedic Institute. 1991;81:219-229.

37. Simmons E, Cameron JC. Patella alta and recurrent dislocation of the patella. Clin Orthop. 1992;Jan:265-269.